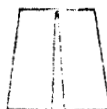(NASA-CR-158505)   HEAT PIPE TECHNOLOGY.   A   N79-76944
BIBLIOGRAPHY WITH ABSTRACTS   Quarterly
Update, 30 Sep. 1977 (New Mexico Univ.)
45 p   Unclas
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QUARTERLY UPDATE SEPTEMBER 30, 1977

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THE UNIVERSITY OF NEW MEXICO
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HEAT PIPE TECHNOLOGY

A BIBLIOGRAPHY WITH ABSTRACTS

QUARTERLY UPDATE

JULY-SEPTEMBER 1977

ASSEMBLED BY

THE HEAT PIPE INFORMATION OFFICE

OF

THE TECHNOLOGY APPLICATION CENTER
INSTITUTE FOR APPLIED RESEARCH SERVICES
THE UNIVERSITY OF NEW MEXICO
ALBUQUERQUE, NEW MEXICO

OCTOBER 1977

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INTRODUCTION

This is the third quarterly update for 1977 in Heat Pipe Technology.

The major portion of this quarter's activities have been in the areas of heat pipe applications in solar energy systems, solar collectors, and waste heat recovery and utilization. There is also a growing number of energy conversion and transport theory publications.

The bibliography is currently undergoing some revision with following quarterly updates incorporating the changes. We feel that these changes will significantly improve the bibliography and more nearly fit today's categories of interest.

We would appreciate any comments or suggestions that you may have to offer towards our effort in making this a more complete and reader responsive publication.

Editor
Gilbert A. Rivera

CONTENTS

**Citation numbers appear on upper right corner of each page

GUIDE TO USE OF THIS PUBLICATION

A number of features have been incorporated to help the reader use this document. They consist of:

-- A TABLE OF CONTENTS listing general categories of subject content and indexes. More specific coverage by subject title/keyword and author is available. through the appropriate index.

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--An INDEX OF AUTHORS alphabetized by author's last
  name. A reference's author is followed by the
  reference's citation number. For multiple authors,
  each author is listed in the index.

--An INDEX OF PERMUTED TITLES/KEYWORDS affords access
  through major words in the title and through an
  assigned set of keywords for each citation. A ref-
  erence's title is followed by the reference's cita-
  tion number. In the indexes, all the words pertaining
  to a reference are permuted alphabetically. Thus,
  the citation number for a reference appears as many
  times as there are major title words or keywords for
  that reference. The permuted words run down the center
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  appear adjacent to a permuted word. Since a title
  or set of keywords is allowed only one line per per-
  muted word the beginning, the end, or both ends of a
  title or set of keywords may be cut off; or, if space
  permits, it will be continued at the opposite side of
  the page until it runs back into itself. A # indicates
  the end of a title or set of keywords while a / indi-
  cates where a title or set of keywords has been cut
  off within a line.

I. GENERAL INFORMATION, REVIEWS, SURVEYS

HP77 10005   HEAT PIPE - A TOOL AND A CHALLENGE

Waters, E.D., (McDonnell Douglas Astronaut Co., Richland, WA), Published
by AIChE, New York, NY, V 1:874-875, 1976, Intersoc Energy Convers Eng
Conf, 11th, Proc, Stateline, NV, Sept 12-17, 1976
Avail:TAC

The heat pipe offers unique and even remarkable characteristics
which make it ideally suited for some energy transport and conversion
applications. It is a passive device which allows heat transport over
relatively long distances, allows heat flux transformation, and allows
energy transport on/off or variable control. These 'thermal conductor'
functions are accomplished with a minimum of potential (temperature)
loss, much as electricity is transported and controlled by passive
electrical conductors and components. By suitable selection of working
fluids, these functions of a heat pipe can be carried on at temperatures
ranging from less than 70° to over $2400^\circ K$.

(ENERGY TRANSPORT, ENERGY CONVERSION, THERMAL CONDUCTOR)

II. HEAT PIPE APPLICATIONS

II. A. GENERAL APPLICATIONS

HP77 20019   PHOTOLUMINESCENCE SPECTROSCOPY OF DIATOMIC MOLECULES
              FINAL REPORT, June 1, 1974 - May 31, 1976

Broida, H.P., (California University, Santa Barbara, CA), 60 p., AD-
A031109, N00014-69-A-0200-8013, No 0014-75-C-0829, N77-19202
Avail:TAC
     Optical spectroscopy has been used to study laser spectrochemistry
of B12 molecules. Molecular constants and new electronic states of B12,
energy exchange between B12 and foreign gases, lifetimes of excited
states, and chemical reactions between bismuth vapor and several oxi-
dants have been measured. Two different types of apparatus, a flow
furnace system and a heat pipe system were used for bismuth sources.
Special attention has been given to reactions of bismuth with various
oxidants in heat-pipe reactors. Preliminary surveys of reactions of
aluminum and calcium with hydrogen containing molecules were made. A
'Photon Correlator' which is a delayed coincidence device, has been
constructed to measure lifetimes and time resolved spectra of a very
weak signal. Capabilities of this device were successfully demonstrated
by measurements of lifetimes of 12 in single rotational transitions.
Some interesting new results were obtained in the laser photoluminescence
of CA2 in the heat-pipe.

(PHOTOCHEMICAL REACTIONS, ELECTRON STATES, HEAT-PIPE REACTORS)

HP77 20020   THE SOLAR SYSTEM IN THE SOLAR HOUSE DORNIER/RWE ESSEN

Gehrke, H., (Arbeitsgemeinschaft Solarenergie, Tagung Auf der Deutschen
Bauausstellung, Essen, West Germany, Jan 29-Feb 6, 1977), Energiewirt-
schaftliche Tagesfragen, V 27:201-202, Mar 1977, A77-28682, In German
     The described project involves an inhabited one-family house which
contains on its roof solar energy collectors with an active area of
65 sq meters. The solar system of the house includes also a storage
capacity of 7 cu m and a heat pump. Particular attention is given to
the design and the operational advantages of the solar energy collec-
tor, details of system operation in the case of normal and weak solar
irradiation, differences between the operation of the system in summer
and in winter and heat pipe utilization.

(HEAT STORAGE, HEAT TRANSFER, TEMPERATURE CONTROL)

HP77 20021   STUDY OF TECHNICAL OPTIONS AVAILABLE FOR RECLAIMING HEAT
              LOST TO THE ATMOSPHERE FROM EXISTING MECHANICAL DRAFT
              COOLING TOWERS - FINAL REPORT

(Gordian Associates, Inc., New York, NY), 27 p., PB-261752/0, FEA/D-
76/199, FEA-CO-04-50235-00, N77-22682
Avail:TAC

Options available were investigated for the recovery of waste heat currently lost to the atmosphere from mechanical draft cooling towers. A variety of useful purposes to which the warm water may be put, are listed. The use of heat pipes for more efficient heat exchange is described.

(HEAT EXCHANGERS, MECHANICAL DEVICES, WASTE-HEAT RECOVERY)

HP77 20022   HEAT PIPE EARLY FUEL EVAPORATION

Harned, J.L., (General Motors Corp., Detroit, MI), SAE Technical Paper No. 760565, 11 p., 1976
Avail:TAC

An evaluation of heat pipes for providing early fuel evaporation in spark ignition engines is presented; 2 design concepts are described. The system can be used as a self-regulating system without direct coupling of intake and exhaust manifolds at some sacrifice in warm-up rate from that of direct exhaust heat. A car, weighing 1360 kg, equipped with a system of lean mixture carburetion, heat pipe, and exhaust gas recirculation, achieved emission levels of 0.7 grams/minute hydrocarbons, 5.8 grams/minute CO and 1.7 grams/minute NO_x with good cold start driveability. Durability of heat pipes in the automotive environment and H formation in water-stainless steel heat pipes require critical evaluation before considering production.

(SPARK-IGNITION ENGINES, CARBURETION)

HP77 20023   SOLAR COLLECTORS - TECHNOLOGY AND PRINCIPLES OF OPERATION

Kalischer, P., Energiewirtschaftliche Tagesfragen, V 27:175-178, March 1977, A77-28676, In German

A description is presented of flat plate solar collector systems. Such systems do not require devices for the concentration of solar energy. Another advantage of the considered systems is related to the possibility to utilize also the diffuse solar radiation. All solar flat plate collectors consist basically of devices for the transformation of the received solar radiation into heat, devices for the controlled removal of the obtained heat, and devices for limiting thermal losses of the collector to the environment. Attention is given to the 'classical'collector type, the heat pipe collector, the flat plate collector utilizing evacuated glass tubes for limiting thermal losses, the efficiency of flat plate collectors, suitable approaches for increasing this efficiency, and operational requirements.

(HEAT-PIPE COLLECTOR, OPERATIONAL REQUIREMENTS)

HP77 20024   USE OF HEAT PIPES IN CALIBRATING THERMOMETERS

Laurencier, A., Coville, P., Mes., Regul., Autom., V 41:57-60, N11, 1976, In French

A range of temperatures is obtainable with liquid in a heat pipe by varying the partial pressure of the vapor by the addition of a gas. Thus $\Delta T = -(T^2/A)(\Delta V/V)$, where ΔT, is the temperature change when the

volume is increased by ΔV and A is a constant. With Na, A is 1.24 x 10^4, and with Cs, A is 8.84 x 10^3. The temperature in a Ag bath heated with 8 heat pipes was maintained within $\pm$ 0.2° of uniformity for 2 hr.

(PARTIAL PRESSURE VARIATION, GAS ADDITION, UNIFORM TEMPERATURE)

HP77 20025   ENERGY SAVING HEAT-PIPE APPLICATIONS FOR RESIDENTIAL AND
              COMMERCIAL APPLIANCES

Lazaridis, L.J., (Thermo Electron Corp., Waltham, MA), White, J.W., ed., (Institute of Gas Technology, Chicago, IL), Proceedings of the third conference on natural gas research and technology, Dallas, TX, Paper No. 5, 22 p., March 6, 1974, Conf-740387
Avail:TAC
     Heat pipes are described with respect to requirements, performance and materials. Proposed uses in gas-fired appliance as a means of improving efficiency are described and illustrated.

(GAS-FIRED APPLIANCES, PERFORMANCE, MATERIALS)

HP77 20026   ANALYSIS OF THE TRANSIENT HEAT CONDUCTION BETWEEN HEAT
              EXCHANGER PIPES AND THE EARTH FOR HEAT PUMP APPLICATIONS

Neiss, J., Winter, E.R.F., (Technische Univ., Inst fuer Thermodynamik and Fluidmechanik, Hydraulik und Energetik), Waerme-Stoffuebertrag, Muenchen, Germany, F.R., V 9:39-48, N1, 6 refs, 1976, In German
     In searching for new energy sources, consideration has been given in recent years to the utilization of heat stored in the earth. Heat pump units were installed in selfcontained houses in northern Germany, removing heat from near the surface of the earth by means of heat pipes. A mode a calculation is demonstrated for the transient conduction of heat to or from pipes near the surface of the earth, using experimental, analytical and numerical methods.

(SELF-CONTAINED HOUSES, HEATING, NUMERICAL METHODS)

HP77 20027   EXPERIMENTAL EVALUATION OF A CYLINDRICAL PARABOLIC SOLAR
              COLLECTOR

Ramsey, J.W., (Minnesota University, Minneapolis, MN), Gupta, B.P., Knowles, G.R., (Honeywell Energy Resources Center, Minneapolis, MN), American Society of Mechanical Engineers, Winter Annual Meeting, New York, NY, Dec 5-10, 1976 ASME Paper 76-WA/HT-13, 8 p., NSF-ERDA-Supported Research, A77-26473
Avail:TAC
     Results are presented for a series of solar collector experiments in which the incident solar flux was concentrated by a single-axis tracking parabolic trough mirror. The concentrated solar flux was directed onto an absorber tube whose axis coincided with the focal axis of the concentrator. The performance of the collector was evaluated, using three different absorbers, a black painted tube designed to operate near ambient temperature, a heat pipe which had a selective solar absorber coating applied to its surface, and a heat pipe which had its surface coated with a non-selective black paint. The peak efficiency

for the collector in the absence of heat losses is approximately
62%, when the incoming solar energy is normal to the collector
aperture. The heat losses which occurred at elevated temperatures
(300°C) decreased the peak efficiencies to 50 and 30%, respectively,
for the selectively coated and black painted tubes. The experi-
mental results establish the technical feasibility of using para-
bolic trough collectors for applications requiring thermal energy
at temperatures up to 300°C.

(SOLAR-ENERGY CONVERSION, TEMPERATURE EFFECTS, THERMODYNAMIC EFFI-
CIENCY)

HP77 20028   TECHNOLOGIES LEAD TO CONSERVATION --- IN MUNITION
              PLANTS

Selman, A.L., Swotinsky, J.M., (U.S. Army, Manufacturing Technology
Directorate, Picatinny Arsenal, Dover, NJ), Mantech Journal, V 2:
41-48, Winter 1977, A77-36634
Avail:TAC
     Measures aimed at energy conservation in munitions production
under the DOD, a heavy energy-consuming sector in one of the nation's
largest energy users, are described and evaluated. Opportunities for
energy conservations are seen in improved insulation, waste heat re-
covery, reduced forging temperatures, energy reclamation from solid
wastes, removal of high-explosive fillers with a cavitating water jet,
and applications of advanced technologies (biomass conversion, geo-
thermal steam and water utilization, solar energy, nuclear power).
Audits of production steps to identify foci of energy wastage, appli-
cations of infrared thermography in energy inventorying, and use of
heat pipe to recover waste heat are discussed.

(WASTE-ENERGY UTILIZATION, ENERGY CONSERVATION, INDUSTRIAL PLANTS)

HP77 20029   LASER SPECTROSCOPY OF DIATOMIC MOLECULES - DETERMINATION
              OF MOLECULAR CONSTANTS

Vidal, C.R., (Max-Planck-Institut Fuer Extraterrestrische Physik,
Garching, West Germany), Ljubljana, Universza V Ljubljani, p. 807-836,
1976, In Physics of ionized gases 1976; proceedings of the eighth
International Summer School, Dubrovnik, Yugoslavia, Aug 27-Sept 3,
1976, A77-33625
Avail:TAC
     Laser spectroscopic techniques for evaluating electron transi-
tions of diatomic molecules in the visible and the UV part of the
spectrum, and which require molecular parameters such as potential
curves, dunham coefficients, transition probabilities, life times,
collisional cross sections, and related quantities, are reviewed.
Absorption measurements, resonance fluorescence measurements, level
crossing spectroscopy, saturation (lamb dip) spectroscopy, and other
methods involving nonlinear optics are discussed. The heat pipe oven,
used to generate samples of well-defined pressure, temperature, and
optical path length, is described. A theoretical method is presented
for reducing laser spectroscopic data. This method is based on an
inverted perturbation approach which - within the Born-Oppenheimer
approximation - provides a quantum mechanical rotationless potential

by fitting in a least squares sense the measured term values to the energy eigenvalues of the hamiltonian of a rotating vibrator.

(HEAT PIPE OVEN, OPTICAL RESONANCE, ULTRAVIOLET SPECTRA)

HP77 20030   HEAT TRANSFER CHARACTERISTICS OF HEAT PIPES

Harada, K., Inoue, S., Fujita, J., Suematsu, H., Wakiyama, Y., Hitachi Zosen Giho, V 37:153-162, N3, Sept 1976, In Japanese
     The heat pipe, an excellent heat transfer element, is expected to become one of the most important elements in heat transfer techniques in the near future. Research on applying heat pipes to a waste heat recovery apparatus (gas-to-gas heat exchanger) is reported. To find low cost heat pipes having characteristics satisfactory for this purpose, heat transfer experiments were performed using several kinds of heat pipes which were commerically available from two companies in Japan, and others experimentally produced by us. The heat pipes produced by us are confirmed to be excellent for both low cost and performance.

(WASTE HEAT RECOVERY, COMMERCIAL HEAT-PIPES, LOW COST)

HP77 20031   DESIGN AND COSTS OF HIGH TEMPERATURE THERMAL STORAGE DE-
              VICES USING SALTS OR ALLOYS

Kauffman, K.W., Lorsch, H.G., (Franklin Institute Research Laboratories, Philadelphia, PA), American Society of Mechanical Engineers, Winter Annual Meeting, New York, NY, 11 p., Dec 5-10, 1976
Avail:TAC
     Salts and alloys are investigated for application to phase change thermal energy storage for conventional and solar thermal power gen- eration. The total storage cost using alloys is insensitive to the heat exchanger cost per unit area and relatively insensitive to changes in discharge time and temperature between charging and discharging. For the salts, total cost is very dependent on those same parameters. Alloys are substantially lower in cost for charge or discharge times of 12 hr or less. The effect of volume change of fusion on total cost is determined. Costs may be increased up to 37 per cent for salts, 2.5 per cent for alloys. Also discussed are the use of metal foam fillers with salts, corrosion, cost of preparation and the use of heat pipes and mechanical devices.

(ECONOMICS, COST-EFFECTIVENESS, SOLAR-ENERGY CONVERSION)

II. B.   THERMIONIC AND THERMOELECTRIC CONVERTERS

HP77 21002   AN INVESTIGATION OF ELECTROHYDRODYNAMIC HEAT PIPES - FINAL
              REPORT

Loehrke, R.I., (Colorado St Univ., Ft Collins, CO), NASA-CR-151977, 51 p., NGR-06-002-127, N77-22422
Avail:TAC

The principles of electrohydrodynamic heat pipe operation are first discussed. Evaporator conductance experiments are then described. A heat pipe was designed in which grooved and ungrooved evaporator surfaces could be interchanged to evaluate the necessity of capillary grooves. Optimum electrode spacing was also studied. Finally, heat convection in evaporating thin films is considered.

(HEAT TRANSFER, THERMAL CONDUCTIVITY, THIN FILMS, HEAT CONVECTION)

II. C.   AEROSPACE ORIENTED APPLICATIONS

HP77 22011   TRANSMITTER EXPERIMENT PACKAGE FOR THE COMMUNICATIONS TECHNOLOGY SATELLITE

Farber, B., Goldin, D.S., Marcus, B., Mock, P., (TRW Defense and Space Systems Group, Redondo Beach, CA), NASA-CR-135035, NAS3-15839, N77-24332
Avail:TAC
The operating requirements, system design characteristics, high voltage packaging considerations, nonstandard components development, and test results for the transmitter experiment package (TEP) are described. The TEP is used for broadcasting power transmission from the communications technology satellite. The TEP consists of a 12 GHZ, 200-watt output stage tube (OST), a high voltage processing system that converts the unregulated spacecraft solar array power to the regulated voltages required for OST operation, and a variable conductance heat pipe system that is used to cool the OST body.

(POWER TRANSMISSION, SOLAR ENERGY CONVERSION, SOLAR ARRAYS)

HP77 22012   STUDY OF AN SLN-TEST PLATFORM FOR THERMAL COMPONENTS (HEAT PIPES AND LATENT HEAT ACCUMULATORS)

(Transemantics, Inc., Washington, DC), NASA-TT-F-16772, Washington NASA 18 p., Mar 1977, Transl into English from Studie einer SLN-Test platform for Thermische Komponentem (Warmetohre und Latentwarmespeicher); West German report, p. 1-16, Dec 1976, (Contract NASw-2792), N77-18389
Avail:TAC
The SLN test platform made possible the examination of thermal components - heat pipes and latent heat accumulators in the module of the spacelab. The interface to the experiments is considerably simplified in the following points: safety regulations, mechanics, cooling, current supply, data acquisition and processing.

(LATENT HEAT, THERMAL COMPONENTS, SPACELAB MODULE)

II. B. NUCLEAR SYSTEMS

HP77 23002   GRAPHITE CURTAIN VACUUM OUTGASSING AND HEAT TRANSFER -
             QUARTERLY PROGRESS REPORT NO. 3, JULY 1, 1976-SEPTEMBER
             30, 1976

Fivel, H.J., Lang, G.P., (McDonnell Douglas Astronautics Co., St.
Louis, MO), 34 p., 1976, (Contract EY-76-C-02-2802), COO-2802-3
Avail:TAC
     Progress during this quarter includes further testing of a sodium
filled heat pipe in a magnetic field of up to 1 Tesla, thermal con-
ductivity measurements on graphite fibers, a preliminary steady state
heat transfer analysis of several graphite curtain materials, the
effect of neutron irradiation on the dimensional changes of several
graphite fibers, and continued vacuum outgassing and sticking proba-
bility measurements.

(SODIUM, THERMAL CONDUCTIVITY, NEUTRON IRRADIATION)

II. E.   ELECTRICAL AND ELECTRONIC APPLICATIONS

HP77 24001   THERMAL CONTROL OF POWER SUPPLIES WITH ELECTRONIC
             PACKAGING TECHNIQUES - FINAL REPORT

(Martin Marietta Corp., Denver, CO), NASA-CR-150194, 145 p., Feb 1977,
(Contract NAS8-31799), DCN-1-6EC-03940, MCR-77-8, N77-18386
Avail:TAC
     The integration of low-cost commercial heat pipes in the design
of a NASA candidate standard modular power supply with a 350 watt out-
put resulted in a 44% weight reduction. Part temperatures were also
appreciably reduced, increasing the environmental capability of the
unit. A complete 350-watt modular power converter was built and tested
to evaluate thermal performance of the redesigned supply.

(COMMERCIAL HEAT PIPES, WEIGHT REDUCTION, ENVIRONMENTAL CAPABILITY)

III. HEAT PIPE THEORY

III. A. GENERAL THEORY

HP77 30009   PROBLEM OF CALCULATING THE MEAN PRESSURE WITHIN A THERMO-
              SIPHON

Novokhatskii, E.M., (Khar'kov Eng-Constr Inst, Ukr SSR), Gorovoi, A.M.,
Izv Vyssh Uchebn Zaved Energ, N9, p. 132-134, Sept 1976, In Russian
     A relation between the temperature and saturation pressure for
$P = 9.81 \times 10^2$ -- 8.83×10^4, as well as a refined method of calculation of
the mean pressure inside a thermosiphon and heat pipe, are proposed.

(NUMERICAL ANALYSIS, SATURATION PRESSURE, TEMPERATURE)

HP77 30010   PRINCIPLES FOR COMPUTING THE EFFICIENCY OF A SYSTEM WITH
              LOW-TEMPERATURE HEAT PIPES

Smirnov, G.F., Journal of Engineering Physics, V 28:131-139, N2, 11
refs, Feb 1975
Avail:TAC
     An approach to the computation of the efficiency of a system
with heat pipes is discussed. Conditions are analyzed for the axial
transport of heat along the wall and framework of a heat pipe. A
scheme for computing the thermal resistance of a heat pipe is recom-
mended. Efficiency criteria are formulated.

(AXIAL HEAT TRANSPORT, THERMAL RESISTANCE, SYSTEM EFFICIENCY)

HP77 30011   HEAT PIPES OPERATING PRINCIPLES AND PERFORMANCE LIMITS

Sauer, E., Schnabel, H., (Zent. Frosch. Tech., VEB Robotron, Karl-Marx-
Stadt, East Germany), Technik, V 31:588-589, N9, 1976, In German
     The structure, operation, applications and limiting factors are
discussed. The capacity is given by $Q = f[\rho(p_1-p^*)]^{0.5} Lp_m + c_f(\tau_m-\tau)]$,
where f is the vapor-space cross section, ρ the diameter, p_1 the vapor
pressure at a chosen initial state, p^* the vapor pressure at the evap-
orator outlet, L the specific heat of evaporation, $p_m = (p_1 + p^*)/2$,
c_f the specific heat of the liquid, $\tau_m: (T_1 + T)/2$ T_1 the absolute tem-
perature at a chosen initial state, T the absolute temperature at the
evaporator outlet, and τ the temperature.

(STRUCTURE, OPERATION, APPLICATIONS, LIMITING FACTORS)

III. B.   HEAT TRANSFER

HP77 31003   STEADY-STATE CHARACTERISTICS OF A THERMOSTATIC GAS FILLED
              HEAT PIPE

Beliakov, A.P., Platunov, E.S., (Leningradskii Institut Tochnoi
Mekhaniki i Optiki, Leningrad, USSR), Priborostroenie, V 19:106-110,
N12, 1976, A77-24968, In Russian
          An analysis is presented of the thermostatic properties of two
types of gas-filled heat pipes used simultaneously for thermal stabili-
zation and cooling of objects with inner sources of heat. Changes in
the intensity of the heat source, and of ·the temperature of the gas-
filled reservoir and the condenser unit are assumed to be the perturb-
ing influences on the heat pipe.

(THERMAL STABILIZATION, COOLING)

HP77 31004   INVESTIGATION OF HEAT EXCHANGE WHEN LIQUIDS ARE BOILED
              IN CLOSED TWO-PHASE THERMOSYPHONS

Bezrodnyi, M.K., (Kiev Polytech Inst., Ukr, SSR), Alekseenko, D.V.,
Izv Vyssh Uchebn Zaved Energ, Leningrad Polytech Inst., im., M.I.
Kalinin, USSR, p. 96-101, 14 refs, In Russian
          Results are presented of an experimental investigation of heat
exchange when liquids are boiled in closed two phase thermosiphons
depending on their geometric dimensions, type of the working fluid,
pressure in the inner cavity and extent to which it is filled with an
intermediate heat carrier. Experiments carried out with water, ethanol,
methanol, freon-11, freon-113 and freon-12 are described. As a result
of the investigation, specific characteristics of heat exchange when
liquids are boiled in heat pipes, compared with the appropriate data
for large-volume conditions, are revealed.

(WATER, ETHANOL, METHANOL, FREON, LARGE VOLUMES)

HP77 31005   CHARACTERISTICS OF HEAT PIPES WITH LIQUID-METAL HEAT CAR-
              RIERS UNDER LOW-TEMPERATURE CONDITIONS

Bystrov, P.J., Popov, A.N., (Moscow, USSR), High Temperature, V 14:
556-562, N3, Nov 1976, English Translation
Avail:TAC
          A method is set forth for the computational and theoretical study
of the characteristics of heat pipes with liquid-metal heat carriers
at low vapor temperatures that takes into account the compressibility
and friction of the vapor flow, the irregularity of the heat load
along the evaporation zone, and the dependence of the heat-carrier pro-
perties on temperature. It is shown that the power of heat pipes under
sonic conditions substantially depends on the geometry of the evapo-
ration zone, viz, the diameter of the vapor channel and the ratio of
zone length to diameter. If flow friction is disregarded, a significant
error appears in the sonic constraint, reaching 50% and more. The
results of the calculation are shown to agree excellently with experi-
mental measurements of thermal fields in a vapor channel and experi-
mental data on the sonic heat transport constraint. The maximum diver-
gence is at most 10%.

(NUMERICAL STUDY, SONIC HEAT TRANSPORT, HEAT CARRIER PROPERTIES)

HP77 31006   AUGMENTATION OF STEADY-STATE AND TRANSIENT TWO PHASE HEAT
              TRANSFER USING MECHANICAL ACCELERATION

Macken, N.A., (Rensselaer Polytech Inst, Troy, NY), Paul, F.W., ASHRAE
Trans, V 82, Pt 1, 1976, Proc of the ASHRAE Semiannu Meet, Dallas, TX,
p. 932-940, 20 refs, Feb 1-5, 1976
Avail:TAC
     This paper discusses the problem of augmentation of steady-state
and transient two-phase heat transfer using mechanically generated
acceleration fields. The literature review shows that the steady-state
heat transfer and critical heat flux in two-phase flow can be increased
and that analysis suggests that transient response times can be improved
because of the stable liquid vapor interface and lumped nature of the
system. Promising applications of this principle include a rotating
evaporator or boiler, rotating condenser, thermosyphon, and heat pumps.
It is shown that the latter devices can be conceptually adapted to new
compact air-conditioning systems.

(CRITICAL HEAT FLUX, TRANSIENT RESPONSE, APPLICATIONS)

III. C.   FLUID FLOW

HP77 32003   TRANSPORT CHARACTERISTICS OF A HEAT PIPE WITH WATER,
              METHANOL, AND FREON-113 AND SOME CHARACTERISTICS OF ITS
              OPERATION

Asakavicius, I., Gaigalis, V., Eva, V.K., (USSR), V sb., Teplomassoob-
men-b., V 3:216-222, Ch 2, 1976, In Russian
     No abstract available

HP77 32004   LAMINAR VAPOR FLOW IN A HEAT PIPE

Kadaner, Y.S., Rassadkin, Y.P., J Eng Phys, V 28:140-146, N2, 9 refs,
Feb 1975
Avail:TAC
     Laminar vapor flow in the evaporation, adiabatic and condensation
sections of a heat pipe is considered. The problem is solved by using
a parametric method. The solution results in a graph-analytical method
of determining the vapor-pressur loss in all sections of the pipe.

(PARAMETRIC METHOD, GRAPH-ANALYTICAL METHOD, PRESSURE LOSS)

HP77 32005   INVESTIGATION OF THE FLOW AND THE TEMPERATURE DISTRIBUTION
              IN THE VAPOR DUCT OF A HIGH-TEMPERATURE HEAT PIPE

Shevchuk, E.N., Chistopianova, N.V., (Akademiia Nauk Ukrainskoi SSR,
Institut Tekhnicheskoi Teplofiziki, Kiev, Ukrainian SSR), Teplofizika
I Teplotekhnika, p. 75-81, N32, 1977, A77-36708, In Russian
     The problem of calculating the axisymmetric laminar flow of
viscous sodium vapors of variable properties in a high-temperature
heat pipe is formulated and solved. It is shown that the compressibility
of the flow and the chemical transformations occurring in it must be
taken into consideration.

(LAMINAR FLOW, CHEMICAL TRANSFORMATIONS, DUCTED FLOW, SODIUM)

IV. DESIGN, DEVELOPMENT AND FABRICATION

IV. A. GENERAL

<u>HP77 40007</u> DESIGN AND ANALYSIS OF A METHANE-BASED CHEMICAL HEAT PIPE

Vakil, H.B., (G.E., Corp Res and Dev, Schenectady, NY), Kosky, P.G., Publ by AIChE, New York, NY, 1976, SAE Paper 769115, V 1:659-664, 6 refs, 1976, Intersoc Energy Convers Eng Conf, 11th, Proc, Stateline, NV, Sept 12-17, 1976
Avail:TAC

The primary heat of reaction is associated with the reforming reaction and efficient energy transport is contingent on achieving a reasonable degree of chemical conversion in the chemical reactors. The most crucial step is the method by which the supra-stoichiometric steam content is handled. The choice of desirable operating parameters such as reaction temperature, pressure and composition are strongly tied to the nature of the primary energy source and to the type of end-use contemplated for the delivered energy. The chemical heat pipe as an efficient energy delivery system favors high temperature methanation at its delivery points. It is a recommendation that full advantage be taken of the potentially high level of delivered energy by the use, for example, of a back-pressure turbine delivering power and exhausting process steam. In general, the elements of the chemical heat pipe represent some extension of existing power plant or chemical plant engineering. Some of the outstanding difficulties of implementing the methane-based chemical heat pipe are discussed.

(ENERGY TRANSPORT, OPERATING PARAMETERS, METHANATION)

<u>HP77 40008</u> HANDBOOK OF GROOVED HEAT PIPES - FINAL REPORT

Hermann, E., Koch, H., Kreeb, H., Bundesmin, M.P., (Dornier-System G.m.b.H., Friedrichshafer, West Germany), fuer Forsch. U. Technol, p. 231 Dec 1976, BMFT-FB-W-76-17, In German

The handbook consists of materials data, a compilation of the computation procedures and performance documents showing the effects of various parameters. The materials data contain the most important temperature-dependent and temperature-independent materials parameters of ordinary heat-transfer media, some wall-material data, and a compatibility matrix. The performance documents give the maximum powers for different parameters and operating conditions. They permit prior design of grooved heat pipes.

(COMPUTATION PROCEDURES, COMPATIBILITY, PERFORMANCE)

IV. B. WICKS

HP77 41011   BOILING AUGMENTATION WITH STRUCTURED SURFACES

Corman, J.C., (G.E., Schenectady, NY), McLaughlin, M.H., ASHRAE Trans.,
Proc of the ASHRAE Semiannu Meet, Dallas, TX, V 82:906-918, pt 1, 17
refs, Feb 1-5, 1976
Avail:TAC
    The selected results presented demonstrate the wick covered sur-
faces can be used in both a flooded condition and in a capillary
pumped condition to increase the critical heat flux at a heated surface.
In addition, engineering finned surfaces can provide even higher criti-
cal heat fluxes and lower nucleate boiling wall superheats in the in-
termediate (40,000 BTU/hr ft^2) to high heat flux range. Key applications
appear to be to process equipment, such as evaporators, heat pipes and
thermosiphon type devices for power thyristor cooling.

(FLOODED, CAPILLARY PUMPED, WICK, CRITICAL HEAT FLUX)

HP77 41012   CONTACT ANGLES OF WICKS FOR LOW-TEMPERATURE HEAT PIPES

Semena, M.G., (Kiev Polytech Inst., Ukr, SSR), Kostornov, A.G.,
Gershuni, A.N., Zaripov, V.K., Journal of Engr Physics, V 28:147-150,
N2, 7 refs, Feb 1975
Avail:TAC
    The results of an experimental investigation of the contact angles
of high-porosity copper wicks for heat pipes in water and organic
liquids are given. Recommendations for better wetting of the porous
wick structure by the heat-transfer agent are offered.

(HIGH-POROSITY, COPPER, WATER, ORGANIC LIQUIDS, WETTING)

IV. C.   MATERIALS

HP77 42003   THE ELIMINATION OR CONTROL OF MATERIAL PROBLEMS IN WATER
             HEAT PIPES. QUARTERLY PROGRESS REPORT, JULY 1-SEPT 30, 1975

Pittinato, G.F., (McDonnell Douglas Astronautics Co., Huntington Beach,
CA), NSF/RANN/SE/GI-41310/PR/75/7, 41 p., Oct 31, 1975, MDC-G-5481-E
Avail:TAC
    Several different concepts for utilizing solar energy involve the
use of heat pipes to transport energy within the systems. While water
appears to be a desirable working fluid in these heat pipes, several
studies have shown that a chemical reaction can occur between the water
and heat pipe material and thus produce hydrogen gas. The gas is
driven to the condenser end of the pipe where it forms an insulating
plug which lowers the heat pipe performance. This study is designed
to determine the most effective combination of materials, fabrication
methods, and operating procedures for a water heat pipe that will pro-
vide satisfactory performance when used as a local absorption, solar-
thermal energy collector. The heat pipe life tests for the various

candidate materials were continued. All of the pipes are maintaing a constant performance level. In order to determine if the wall thickness of a water heat pipe affects its performance curve, one heavy walled heat pipe was fabricated from each candidate material. The performance recovery rate for the heavy walled heat pipes was slower than that for the thin walled pipes, thus supporting a diffusion dependent recovery mechanism. Two 316 stainless steel heat pipes were fabricated with Inconel 600 condenser end caps. These pipes were found to be self-venting with respect to hydrogen gas.

(ENERGY TRANSPORT, MATERIALS COMPATABILITY, SOLAR COLLECTORS)

HP77 42004   ELIMINATION OR CONTROL OF MATERIAL PROBLEMS IN WATER HEAT PIPES - FINAL REPORT, JAN 1, 1974-March 30, 1976

Pittinato, G.F., (McDonnell Douglas Astronautics West, Huntington Beach, CA), NSF/RANN/SE/AER-74-02056/FR/76/1, 85 p., Mar 1976, MDC-G-5481F
Avail:TAC
    A definition was made of a water heat pipe for use with a parabolic cylindrical solar collector that will operate in the temperature range of ambient to 300°C, and a literature survey was conducted on the problem of noncondensable gas generation in water heat pipes. Heat pipes measuring 76 cm long were fabricated from 316 stainless steel, 347 stainless steel, 430 stainless steel, Monel 400, CDA 715, Inconel 600, Incoloy 800, and copper-lined 304 stainless steel. Of all the materials tested, Inconel 600 appeared to be the most acceptable for full-scale water heat pipes. Inconel 600 generated only a small amount of hydrogen gas and, due to the high permeation rate of the gas through this material, self-vented the hydrogen over a relatively short time period. An equation, based on a diffusion dependent mechanism, was developed that predicts the heat pipe performance recovery rate. A procedure was developed for fabricating the full-scale heat pipes.

(ENERGY TRANSPORT, MATERIALS COMPATABILITY, SOLAR COLLECTORS, FABRICATION)

V. TESTING AND OPERATION

<u>HP77 50019</u>   INVESTIGATION OF MAXIMUM THERMAL FLUXES IN TWO-PHASE
THERMOSIPHONS WITH INTERNAL INSERTS

Bezrodnyi, M.K., (Kiev Polytech Inst, Ukr SSR), Fainzil'berg, S.N.,
Koloskova, N.Ya., Beloivan, A.I., Izv Vyssh Uchebn Zaved Enrg., p. 96-
102, N8, Aug 1976, In Russian
     Results are presented of an experimental investigation of two-
phase thermosiphons of different designs: without inserts, with in-
ternal cylindrical inserts and partitions situated within the heating
zone, with an insert to return the condensate from the zone of heat
removal to the bottom part of the heat removal zone. An increase in
the heat transfer capacity of a thermosiphon is obtained only with
the use of the latter insert thanks to the achievement of steam/liquid
separation at the inlet into the insert. It is found that the optimum
ratio between the areas of the cross section of the duct of the inner
insert and of the outer thermosiphon tube lies within the range of
0.12-0.16. At the same time, the maximum heat transfer capacity of the
thermosiphon is increased 6.8 times compared with a thermosiphon with-
out an insert.

(WICK, HEAT TRANSFER CAPACITY, CROSS SECTION AREAS)

<u>HP77 50020</u>   HEAT PIPES IN FLAT PLATE SOLAR COLLECTORS

Binert, W.B., Wolf, D.A., (Dynatherm Corp., Cockeysville, MD), ASME,
winter annual meeting, New York, NY, Paper 76-WA/Sol-12, 11 p., 9 refs,
Dec 5-10, 1976, A77-26517
Avail:TAC
     The application of heat pipes as heat transport elements in flat
plate solar collectors was investigated. This paper summarizes the
results of component testing and describes, in detail, the performance
of two prototype heat pipe collectors. Heat pipes can be used to sep-
arate the transport fluid from the solar absorber. However, special
care must be taken to minimize the thermal resistance at the interface
between absorber and fluid manifold. An optimized heat pipe collector
has approximately the same thermal performance as an equivalent con-
ventional collector. During intermittent insolation, the unidirectional
heat transport capability of the heat pipes increases the average col-
lection rate over that of a conventional collector.

(HEAT TRANSPORT, COMPONENT TEST, PERFORMANCE TESTING, APPLICATIONS)

<u>HP77 50021</u>   GAS INTERFACE STUDIES IN LARGE HORIZONTAL HEAT PIPES

Deverall, J.E., (Los Alamos Scientific Lab., NM), 16 p., Jan 1977,
(Contract W-7405-ENG-36)
Avail:TAC
     A series of tests was made with a large diamter, horizontal heat
pipe to study the feasibility of maintaining cool zones at the ends
with inert buffer gases for metal vapor laser applications. Studies
were made of the slope and stability of the gas interface with both

water and mercury as the working fluids. Successful operation was achieved using a buffer gas mixture for water vapor and a convection baffle system for mercury vapor. Results indicated that there is a critical heat pipe diameter, which if exceeded requires a definite gas density to establish an effective interface, but for smaller diameters, operation was independent of gas density.

(WATER, STABILITY, GAS INTERFACE, BUFFER GASES, MERCURY)

HP77 50022   ANALYSIS AND TESTS OF NASA COVERT GROOVE HEAT PIPE -
             FINAL REPORT

(Grumman Aerospace Corp., Bethpage, NY), NASA Cleveland, OH, NASA Order C-65532, NASA-CR-135156, 55 p., Dec 1976, N77-20375
Avail:TAC
     A low-cost thermal control heat pipe having nearly covered grooves extruded in aluminum was developed at NASA. Analytical predictions of transport capability are in excellent agreement with experimental results using ammonia. Axial heat transport predictions as a function of fluid charge are presented also for methane, ethane, propane and butane. Experimental tests show performance considerably better than that of open groove extruded pipes and comparing favorably with that of more complicated arterial/wick configurations. For ammonia at 20°C, the covert groove pipe obtained a static wicking height of 2.5 cm and an axial heat transport capability of 143 W-m.

(THERMAL CONTROL, ALUMINUM, METHANE, ETHANE, PROPANE, BUTANE)

HP77 50023 STUDY OF THE THERMAL RESISTANCE OF A CRYOGENIC HEAT PIPE

Piskunov, V.B., Bartkevich, N.Ya., Bakhnev, V.G., Prusman, Yu.O., Khim. Neft. Mashinostr, USSR, V 2:20-21, 1977, In Russian
     The effectiveness of cooling by a cryogenic heat pipe connected to a gas refrigerator was investigated. It was found that the cause of excessive temperature gradients is associated with the thermal resistance of the vapor layer between the liquid N_2 in the wick and the surface of the cooled object. The removal of the vapor layer permits the heat flux to be increased considerably, even at a small temperature gradient between the evaporator and the liquid N_2 in the bath. An effective thermal condition of the wick of 2700 W/m° was attained.

(COOLING, WICK, TEMPERATURE GRADIENTS)

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